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(54) CMOS image sensor having integrated universal serial bus (USB) transceiver

(57) A CMOS camera formed on an integrated circuit is disclosed. The CMOS camera includes: an image

sensor formed on the integrated circuit and a USB controller and transceiver formed on the same integrated circuit.

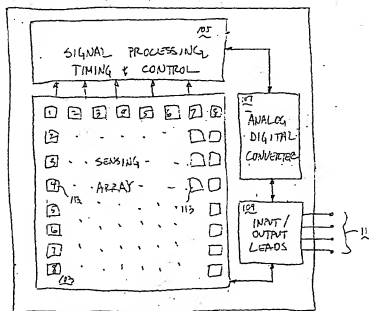


FIGURE 2

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## Description

[0001] The present invention relates to complementary metal oxide semiconductor (CMOS) cameras, and more particularly, to a CMOS camera having integrated circuitry that allows for communication using a universal serial bus (USB).

[0002] Integrated circuit technology has revolutionized various fields including computers, control systems, telecommunications, and imaging. In the field of imaging, the development of a CMOS image sensor has made possible the manufacture of low cost imaging devices. One advantage of the CMOS image sensor is the ability to integrate signal processing logic (typically formed in a CMOS process) with the sensing array to form a single chip CMOS image sensor. OmniVision Technologies, Inc., the assignee of the present invention, manufactures a complete line of CMOS image sensors.

[0003] In many applications, the images produced by the CMOS image sensor are used by personal computers, Internet appliances, and the like. The Universal Serial Bus (USB) specification is one commonly used protocol for a serial bus that supports data exchange between USB compatible devices. One major advantage of the USB protocol is the ability to support plug and play operation, allowing easy installation of peripherals. Because of the popularity of the USB protocol, many peripheral devices must include an integrated circuit that serves as a USB transceiver for the peripheral. Therefore, in the prior art, USB compliant cameras required at least two integrated circuits: one for the actual CMOS image sensor and a USB transceiver.

[0004] A CMOS camera formed on an integrated circuit is disclosed. The CMOS camera includes: an image sensor formed on the integrated circuit and a universal serial bus (USB) transceiver/controller on the same integrated circuit.

#### 4. Brief Description of the Drawings

##### [0005]

Figure 1 is a schematic diagram of a CMOS camera formed in accordance with the present invention.

Figure 2 is a schematic diagram of the image sensor portion of the CMOS camera of Figure 1.

[0006] Referring to Figure 1, a CMOS camera 501 formed in accordance with the present invention is shown. The CMOS camera 501 includes an image sensor 101, an audio codec 505, a USB controller 503, an internal bus 111, an audio bus 507, and a USB bus 509.

[0007] The USB controller 503 operates to transmit and receive data in accordance with the USB protocol. For this reason, the USB controller 503 is also referred to as a USB transceiver. The USB controller 503 is communicatively connected to the image sensor 101 using

the internal bus 111. The image sensor 101 obtains image data and digitizes it for transfer to the USB controller 503 using the internal bus 111.

[0008] The USB controller 503 is connected via a USB bus 509 to a USB host device (not shown). Depending upon the USB host's demands, the USB controller 503 transfers packed serial data (comprising the image data) to the USB host through the USB bus 509. The packed serial data that is transferred by the USB controller 503 is digital image data, such as color or black and white images, RGB raw data, RGB composite data, and/or YC<sub>b</sub>C<sub>r</sub> data with or without additional image processing and data compression.

[0009] Optionally, memory of some sort, including non-volatile and volatile memory may be incorporated into the CMOS camera 501. The non-volatile and volatile memory may be incorporated in the image sensor 101, the USB controller 503, and/or the audio codec 505 to store data, such as a map of the defective pixels found in the sensing array 103, image data, audio data, a plethora of information regarding the attributes of the CMOS camera 501, and signal processing coefficients. [0010] The USB controller 503 can be of conventional design that is available from multiple vendors that have developed USB controllers. Optionally, image/signal processing, data compression, non-volatile and/or volatile memory may be incorporated into the USB controller 503. Alternatively, the USB controller 503 may be of substantially similar design to the Model OV511 product designed and manufactured by the assignee herein.

[0011] Other functions may also be integrated within the CMOS camera 501. For example, in the preferred embodiment shown in Figure 1, an audio codec 505 is included to perform bi-directional transferring of audio data separately or simultaneously. The audio codec 505 allows digitizing, processing, storing and transferring of audio data along with the image data from the image sensor 101. The audio codec 505 also allows playback of audio data stored in the non-volatile or volatile memory portion of the CMOS camera 501 or audio data transferred by the USB controller 503 via the USB bus 509. The audio codec 505 is also of conventional design and communicates to the USB controller 503 via the audio bus 507.

[0012] The CMOS camera 501 can either be controlled by the USB host through the USB bus 509 with reading or writing parameters or commands, or alternatively, be controlled locally as a stand alone camera, for example, by hardwired logic, programmable logic, or I/O pins.

[0013] Figure 2 illustrates in greater detail the image sensor 101 shown in Figure 1. The image sensor 101 includes a sensing array 103, signal processing, timing, and control area 105, analog to digital converter (ADC) 107, and input/output section 109.

[0014] The sensing array 103 includes a plurality of individual pixels 113 arranged in a two-dimensional array. In the diagram of Figure 1, the sensing array 103 has 8 columns and 8 rows. The image sensor 101 also

includes signal processing, timing, and control area 105. As the name implies, this portion of the image sensor 101 contains the logic and other integrated circuit devices that perform the reading out of the sensing array 103, signal processing of the data read out from the sensing array 103, and various timing and other control functions.

[0015] Input/output portion 109 is used by the image sensor 101 to communicate with the USB controller 503 using internal bus 111. As already discussed above, the internal bus 111 is used to primarily transfer image data to the USB controller 503. The internal bus is also used for control signals that, for example, can be used to configure the functionality/modality of the image sensor 101.

[0016] While the preferred embodiment of the invention has been illustrated and described, it will be appreciated that various changes can be made therein without parting from the spirit of scope of the invention. The current invention has been described in relation to a preferred embodiment. One of ordinary skill after reading the foregoing specifications will be able to affect various changes, alterations, and substitutions or equipment without departing from the broad concepts disclosed. It is therefore intended that the scope with the Letters Patent granted hereon be limited only by the definition contained in the affirmative claims and the equivalents thereon, and not by limitations of the embodiments described herein.

[0017] The embodiments of the invention of which an exclusive right or privilege is claimed are defined as follows:

#### Claims

1. A CMOS camera formed on an integrated circuit, said CMOS camera including:

an image sensor formed on said integrated circuit; and  
a universal serial bus (USB) transceiver on said integrated circuit.

2. The camera of Claim 1 further including non-volatile and volatile memory.

3. The camera of Claim 1 further including an audio codec.

4. A CMOS camera formed on an integrated circuit, said CMOS camera including:

an image sensor formed on said integrated circuit;  
an audio codec formed on said integrated circuit; and  
a universal serial bus (USB) transceiver on said

integrated circuit;  
wherein said image sensor and said audio codec provide output signals to said USB controller, said USB controller processing said output signals into USB format, and further wherein said USB controller processes said input signals from USB format, said USB controller providing output signals to said image sensor and said audio codec.

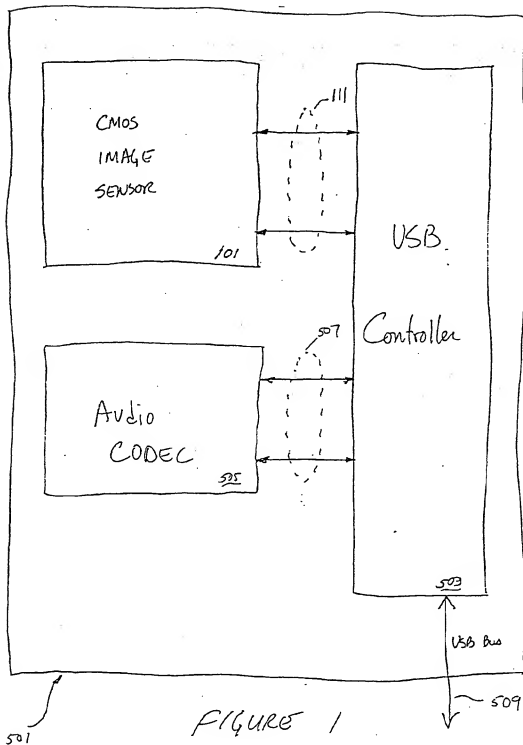


FIGURE 1

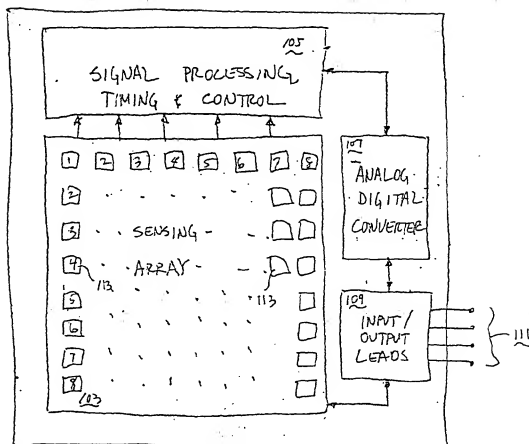


FIGURE 2

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## EUROPEAN SEARCH REPORT

Application Number  
EP 00 31 1099

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The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 12 February 2001	Examiner Agne, M
CATEGORY OF CITED DOCUMENTS X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document		1: theory or principle underlying the invention E: earlier patent document, but published on or after the filing date O: document cited in the application L: document cited for other reasons S: member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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